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Computed tomographic appearances of cardiac amyloidosis

TOHRU SEKIYA,* C J FOSTER, I ISHERWOOD, S B LUCAS, M K KAHN, J P MILLER

From the Department of Diagnostic Radiology, and the Computational Group, University of Manchester Medical School; the Department of Cardiology, Manchester Royal Infirmary; and the Departments of Medicine and Histopathology, University Hospital of South Manchester, Manchester

SUMMARY Computed tomography was used to identify the characteristic appearances of histologically confirmed cardiac amyloidosis in two patients. Mean myocardial density and 95% confidence limits in one of these patients (30·6±3·4 Hounsfield units (HU)) were significantly lower than in patients with diffuse hypertrophic cardiomyopathy (range from 38·8±5·7 HU to 45·9±4·4 HU) and normal myocardium (range from 41·9±4·3 HU to 44·8±4·4 HU) on pre-contrast computed tomograms. Although only an approximate myocardial density was obtained in the second patient with amyloidosis, a similar result (30 HU) was noted on pre-contrast tomograms. Diffuse thickening of the interventricular septum and left ventricular free wall was found in both patients. Myocardial density on post-contrast computed tomograms was 102·8±5·2 HU in one patient and approximately 100 HU in the other. A pericardial effusion was noted in the first patient. A low myocardial density on pre-contrast tomograms and diffuse myocardial thickening on post-contrast tomograms are considered to be important features of cardiac amyloidosis.

Amyloidosis is a rare disease of unknown aetiology, which may affect almost any organ in the human body. Its pathogenesis is still unknown, but a classification into "immunocyte dyscrasias with amyloidosis" and "reactive systemic amyloidosis" has been suggested.[1] Appreciable deposits of amyloid in the heart are usually identified in the former type. There are no characteristic symptoms or clinical signs of cardiac amyloidosis, and the diagnosis is often difficult during life. The computed tomographic appearances of cardiac amyloidosis in a single case have been reported,[2] but detailed changes in the disease detected by computed tomography have not been described. This report presents the computed tomographic appearances in two patients with confirmed cardiac amyloidosis.

Patients and methods

CASE 1

A 48 year old man, known to be an ethanol abuser, had a one year history of anorexia and weight loss and a seven month history of upper abdominal and lower chest pain. Physical examination showed that the patient had bilateral Dupuytren's contractures and spider naevi on the upper trunk. There was pronounced ankle, sacral, and genital oedema. The abdomen was distended with hepatomegaly and ascites. The blood pressure was 130/90 mm Hg, and an erythrocyte sedimentation rate was 100 mm/first hour. Serum albumin concentration was 18 g/l (normal 33–48 g/l) with a urinary protein loss of 4·8–9·0 g per day. The nephrotic syndrome was diagnosed. Plasma protein electrophoresis showed an IgM monoclonal band. An iliac crest trephine biopsy showed evidence of amyloid deposition. Electrocardiography indicated partial left bundle branch block.

Computed tomography was performed with a General Electric CT/T 8800 ungated scanner, incorporating a scan time of 5·8 s. Scans of 10 mm thickness were obtained at 120 kVp and 400 mA. Pre-contrast and post-contrast scans with an intravenous injection of 100 ml of meglumine iothalamate (280 mg of iodine per ml) into an antecubital vein at a flow rate of 2 ml/s using a Medrad Mark IV power pump were performed at 10 mm intervals through the heart. Myocardial density was measured by 10 rectangular regions of interest of

Requests for reprints to Dr T Sekiya, Department of Radiology, Jikei University School of Medicine, 3-25-8- Nishi-shinbashi, Minato-ku, Tokyo 105, Japan.

*Present address: Department of Radiology, Jikei University School of Medicine, 3-25-8 Nishi-shinbashi, Minato-ku, Tokyo 105, Japan.

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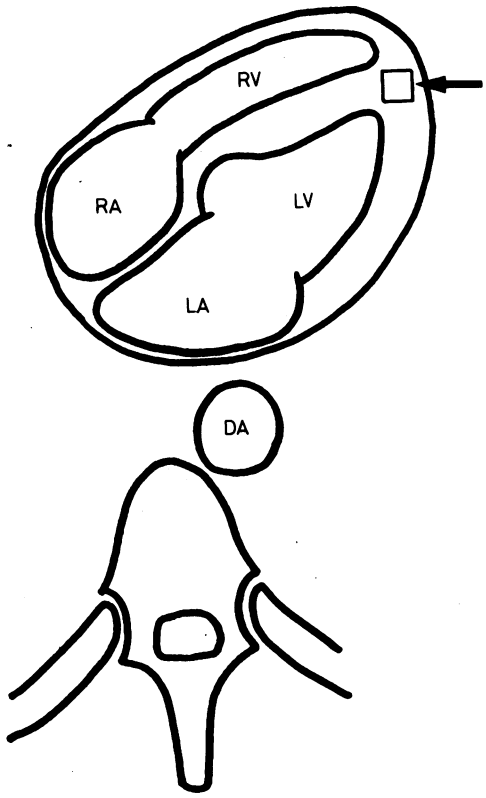

Fig. 1 *Diagram to show measurement of myocardial density from a rectangular region of interest (arrow) of either 9 or 25 pixels. The density of the area is calculated by commercially available software. RA, right atrium; RV, right ventricle; LA, left atrium; LV, left ventricle; DA, descending aorta.*

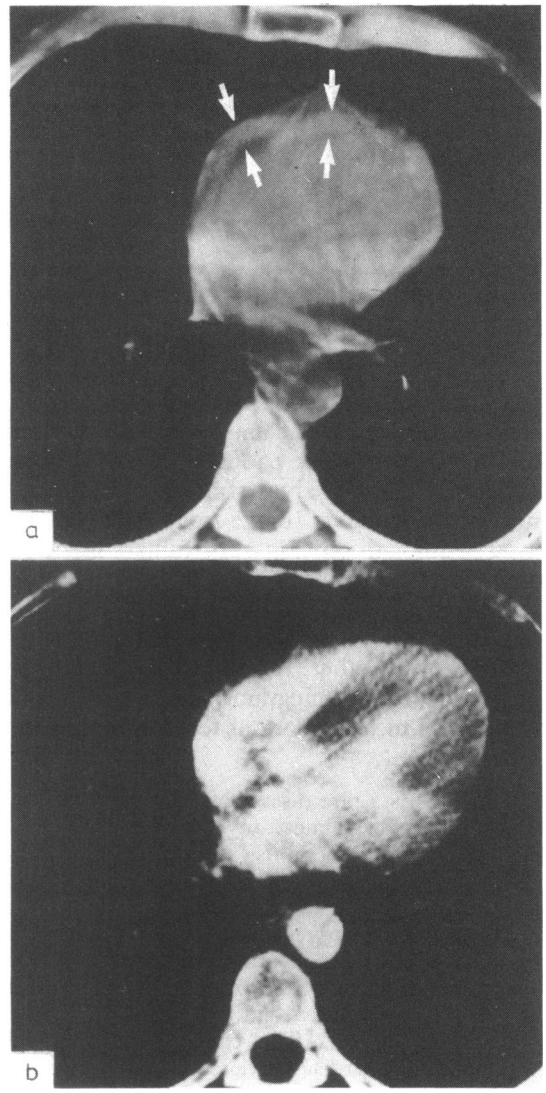

Fig. 2 *Case 1: pre-contrast computed tomograms showing (a) a pericardial effusion (arrows) and (b) diffuse thickening of the left ventricular myocardium.*

either 9 or 25 pixels on multiple sections (Fig. 1). Pre-contrast computed tomograms showed a pericardial effusion (Fig. 2a); myocardial density was 30·6±3·4 Hounsfield units (HU). Post-contrast tomograms showed diffuse thickening of the inter-ventricular septum (2·3 cm) and the left ventricular free wall (Fig. 2b); myocardial density was 102·8±5·2 HU.

The patient was treated with melphalan, prednisolone, and allopurinol and underwent plasmapheresis twice a week with no clinical benefit. A pronounced deterioration in his condition was noted. He subsequently developed disseminated intravascular coagulopathy and died 19 days after computed tomography. At necropsy primary systemic amyloidosis affecting the liver, gastrointestinal tract, spleen, bone marrow, and heart was confirmed. The histology of the heart showed extensive deposition of amyloid in the interstitium, in the walls of the blood vessels, and in the myocardial fibres. The pericardial sac contained approximately 50 ml of clear fluid with focal deposition of amyloid predominantly around the blood vessels.

CASE 2

A 58 year old woman who had had chemotherapy for multiple myeloma for three years presented with increasing breathlessness. On physical examination

she was dyspnoeic at rest but had no oedema, hepatomegaly, or joint abnormality. The pulse was regular at the rate of 80 beats/min, and the peripheral blood pressure was 110/80 mm Hg. The heart sounds were normal, but pronounced bilateral basal crepitations were noted. Laboratory data showed evidence of progression of the previously noted myelomatosis.

A chest radiograph showed an increase in the transverse cardiac diameter. Electrocardiography indicated sinus rhythm with unifocal ventricular extrasystoles, partial right bundle branch block, and right axis deviation. Echocardiography showed a diffusely increased myocardial thickness of granular appearance and low echogenicity in the ventricular septum. Angiography showed poor left ventricular function and a diffusely thickened myocardium. The ventricular cavity and coronary arteries were normal.

Computed tomography was performed in the same way as in case 1. Precise numerical data were not available for review in this case because of technical problems, and only an approximate myocardial density obtained at the time of examination could be used. Pre-contrast tomograms showed a notably enlarged heart and a left pleural effusion; myocardial density was approximately 30 HU. Post-contrast tomograms showed a notably thickened interventricular septum (2·6 cm) and left ventricular free wall (Fig. 3); myocardial density was approximately 100 HU. A large amount of ascites and a dilated inferior vena cava were noted.

The patient developed severe right and left cardiac failure and bronchopneumonia and despite treatment with large doses of diuretics and antibiotics her condition deteriorated steadily. She died 14 days after examination. At necropsy, in addition to multiple myelomatosis, amyloidosis affecting the tongue and heart were noted. The myocardium was greatly thickened in all areas, particularly the left ventricular wall and the interventricular septum. The myocardium was firm and waxy, and immersion in iodine showed diffuse infiltration with amyloid.

STATISTICAL ANALYSIS OF MYOCARDIAL DENSITY

Densities of myocardium with amyloid infiltration on pre-contrast computed tomograms were compared with similar values for three patients with clinically confirmed diffuse hypertrophic cardiomyopathy and also for 10 patients with a normal myocardium.

The mean myocardial density and 95% confidence limits for one patient with amyloidosis (case 1) was 30·6±3·4 HU, whereas those for three patients with diffuse hypertrophic cardiomyopathy ranged from 38·8±5·7 HU to 45·9±4·4 HU and for 10 patients with a normal myocardium from 41·9±4·3 HU to 44·8±4·4 HU (Fig. 4).

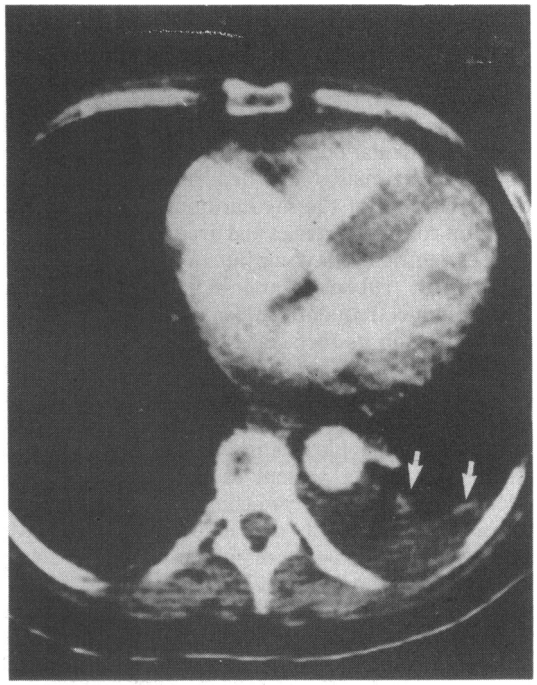

Fig. 3 *Case 2: post-contrast computed tomograms showing diffuse thickening of the left ventricular myocardium and a left pleural effusion (arrows).*

A one way analysis of variance and Dunnett's method[3] indicated that the mean myocardial density of the patient with amyloidosis (case 1) was significantly different from that of all the other patients. The mean myocardial density of the second patient, for which no measure of variation was available, was 30 HU.

Discussion

Necropsy studies have shown that myocardial

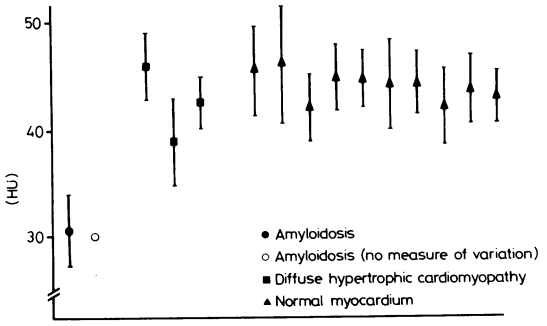

Fig. 4 *Mean values of myocardial density of all patients together with 95% confidence limits. HU, Hounsfield units.*

involvement is present in 90% of patients with primary and myeloma related amyloidosis and in 54% of patients with secondary amyloidosis.[4] Any structures in the heart may be the site of amyloid deposition. The amount may vary from an occasional small nodule or vascular cuff to almost total replacement of the myocardial mass.[5] The deposition may be within the interstitium of the myocardium, subendothelial, or within coronary arteries and around arterioles.[6] An affected ventricular myocardium at necropsy is thickened, firm, rubbery, and non-compliant.[7] The pericardium is frequently affected, and small nodules may be seen on its surface.[5]

Differentiation of cardiac amyloidosis from constrictive pericarditis is important because the treatment and prognosis are entirely different.[8] The computed tomographic appearances of cardiac amyloidosis in the present cases—namely, a lower myocardial density on pre-contrast tomograms and diffuse thickening of the myocardium on post-contrast tomograms—are dissimilar to the previously described appearances in constrictive pericarditis—namely, pericardial thickening,[9] a deformed ventricular contour, and angulated interventricular septum.[10] Echocardiography[11 12] and angiography[13] remain the imaging methods of choice in the differentiation of cardiac amyloidosis from constrictive pericarditis, but computed tomography may also provide useful information.

Differentiation of cardiac amyloidosis from primary hypertrophic cardiomyopathy is also important. Echocardiography[11 12 14 15] and scintigraphy[16–18] can provide useful information in this respect. The density of the myocardium on pre-contrast tomograms in one patient with amyloid infiltration (30·6±3·4 HU) was significantly lower than the densities in three patients with diffuse hypertrophic cardiomyopathy, who had densities similar to a normal myocardium (Fig. 4). Although only an approximate myocardial density was obtained in the second patient with cardiac amyloidosis, the density on pre-contrast computed tomograms was similar to that of the first patient. The lower density of the affected myocardium on computed tomography is important in the differentiation of the disease because both diseases may appear as diffuse thickening of the myocardium (Figs. 2b and 3).[2]

The limited number of patients precludes a precise definition of the role of computed tomography in the diagnosis of cardiac amyloidosis. Differentiation between cardiac amyloidosis and constrictive pericarditis is, however, quite possible. Furthermore, if the above appearances—namely, a lower myocardial attenuation value on pre-contrast tomograms and diffuse myocardial thickening on post-contrast tomograms with or without a pericardial effusion—are noted in a patient with histologically confirmed amyloidosis in any other organ, then cardiac involvement by the disease must be strongly suspected.

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